Oberbeck's general circulation. Helmholtz' horizontal rolls. The investigations of Diro Kitao, Guldberg and Mohn, Marchi, Boussinesq, A. Poincaré, Sprung, Siemens, Moeller, Ekholm, Ritter, Lindeloff, Margules and Hermann into the motions of the atmosphere. Viscosity and discontinuity. The possible special solutions of the general equations of fluid motions that apply to the true atmospheric circulation, both on the earth and on the other planets. Atmospheric tides; theories of Laplace, Ferrel, Rayleigh, Margules, A. Poincaré. Theories of atmospheric electricity.

Time.—Eighty lectures and an additional four hours a week given to special reading and investigation and to the preparation of the final thesis, as closing the four years' course.

Concomitant Studies.—Riemann's *Differential Gleichungen:* Auerbach's *Hydrodynamics;* Lamb's *Hydrodynamics* (new edition); physical laboratory work in gaseous motions, optical and electrical phenomena.

THE METEOROLOGICAL LABORATORY.

In order to carry out an ideal course in meteorology it is necessary to not merely study lectures and text-books but the current daily weather maps; to practice the use of instruments and to keep weather records; to investigate special questions in local climatology, and to personally explore the atmosphere.

In the meteorological laboratory the student should investigate experimentally questions that arise in relation to the motions of the atmosphere, which includes almost every pertinent form of experiment in the motions of fluids and gases. Provision should also be made for the study of such optical phenomena of the atmosphere as refraction, absorption, interference, scintillation, mirage, and sunset colors.

This laboratory should also provide for study and practice with self-registers, the study of the thermo-dynamics of the air and aqueous vapor; the determination of the amount of heat received from the sun; the continuous records of atmospheric electricity, terrestrial magnetism, earth currents, the tides and earthquakes.

The laboratory should also provide mathematical apparatus or mechanical devices by which complex questions in the motion of the atmosphere may be solved.

Facilities should be given for the study of atmospheric dust, especially in its relation to the temperature of the air and to the formation of clouds and rain.

The laboratory should contain a working library and bibliography.

CLEVELAND ABBE.

WASHINGTON, D. C.

GEOLOGIC ATLAS OF THE UNITED STATES.

FOLIO 1, LIVINGSTON, MONTANA, 1894.

THIS folio consists of $3\frac{1}{4}$ pages of text, a topographic sheet (scale 1:250,000), a sheet of areal geology, one of economic geology, one of structure sections, and one of giving a columnar section. The text is signed by Joseph P. Iddings and Walter H. Weed, geologists, and Arnold Hague, geologist in charge.

The area of country covered by the folio lies between the parallels of latitude 45 and 46 and the meridians 110 and 111, and embraces 3,340 square miles. It is within the State of Montana, including portions of Gallatin and Park counties, and the town of Livingston is within its limits. The region is elevated, the lowest point being over 4,000 feet, the major portion over 6,000 feet, and the highest peaks over 11,000 feet above sea level.

The principal topographic features are the Snowy Mountains, Gallatin Range, Bridger Range, Crazy Mountains and Yellowstone Valley. The Yellowstone River is the main drainage channel for the area. It enters the district from the Yellowstone

Park about the middle of the southern border, flows northwest and north through a closed valley 30 miles long and three miles wide, and at Livingston turns northeast and enters the broad open valley beyond the frontal ranges of the Rocky Mountains.

The rocks forming the surface of the country are partly crystalline schists, including gneiss, schists, with granite and other granular rocks; partly sedimentary formations, including limestone, sandstone and shales; and partly lavas and other igneous rocks. The crystalline schists are mainly Archean and constitute a large part of the southern half of the region. They form the higher mountains and plateau drained by Boulder River and those from Emigrant Peak south. A small area of sandstones, conglomerates, slates and arenaceous limestones occurring in the Bridger Range have been referred to the Algonkian. They lie unconformably upon the crystalline schists, and are overlain unconformably by the Paleozoic series.

The sedimentary formations cover one-half the area, and present a total thickness of 20,000 feet, embracing all the grand divisions of geologic time since the Archean. The chief feature is the great development of the latest Cretaceous strata, which are 12,000 feet thick above the Laramie, the total thickness of the Paleozoic being only 3,500 feet. The series from the basal (Flathead) quartzite to and including the Laramie coal beds is conformable throughout. The Paleozoic strata occur upturned at steep angles against the crystalline schists or in steep anticlines. The lowest bed is the Flathead quartzite. Above it are shales and limestones of Cambrian age. The Silurian is represented by only a few feet of formation, whose precise age is doubtful. Four hundred and fifty feet of shales and limestones represent the Devonian. The Carboniferous strata are 2,000 feet thick. They are here, as elsewhere, the mountain limestones and form the crest of the Bridger Range and the summits of some peaks of the Snowy Range. The Trias is recognized only in the southern part of the region, as thin belts of red sandstone. The Jura varies considerably in character, being mostly shales and fissile limestones. These two formations are 500 feet thick.

The Cretaceous constitutes more than one-half of the total thickness of strata. Its lowest member is the Dakota conglomerate with sandstone and some shale. Over this is the Colorado group, including Benton shales and Niobrara limestone, aggregating 1,800 feet in thickness. Over this is the Montana group, 1,800 feet thick, consisting of Pierre shales and Fox Hills limestones. The Laramie sandstone, with some intercalated clays and beds of coal, is 1,000 feet thick. Above this is a slight unconformity, followed by conglomerates, sandstones and clays of the Livingston formation 12,000 feet thick. Near the base the conglomerate consists largely of volcanic material. True tuff-breccia of volcanic rocks occurs intercalated near the base of the series on Boulder River.

Neocene lake beds occur in Gallatin Valley, and on Yellowstone River opposite Fridley.

Surficial deposits of the Pleistocene period occur as alluvium over all the broader river valleys. Glacial drift, consisting of gravel, sand and boulders, is scattered over the higher parts of the country and covers the Yellowstone Valley south of Chicory.

Igneous rocks occupy a large part of the area of this sheet. They consist of subaerial breccias or agglomerates with tuffs and lava flows and of intrusive bodies, such as dikes, sheets, laccolites and stocks or necks. They occur extensively in the southeastern corner of the district and form the Gallatin Range along the south-

western border and another area east of Boulder River.

In the Crazy Mountains the igneous rocks are wholly intrusive. The extrusive rocks are andesitic breccia, acid and basic; trachytic rhyolite and basalt. The intrusive rocks are gabbro, diorite, theralite, basic and acid porphyrties, basic and acid andesites, and dacites. Several centers of volcanic eruptions, active in early Tertiary time, occur in the region. They are at Emigrant Gulch, Haystack Mountain and Crazy Mountains. Other centers are just outside of the limits of the atlas sheet.

The chief economic deposits of the district are the gold-bearing gravels of Emigrant, Bear and Crevice Gulches. They have been worked on a small scale. Gold veins occur in Emigrant Gulch, Crevice Gulch and Haystack Mountain. Copper ores in small quantities have been found at the head of Boulder River and of Slough Creek. Clays serviceable for brick-building occur in the alluvium near Livingston and in the lake beds near Bozeman, also in the Cretaceous strata. Two coal fields exist within the district, the Cinnabar field and the Bozeman field. The aggregate thickness of the seams is from 12 to 18 feet, made up of a number of seams, only three of which are workable. The coal is bituminous, of variable character, and in places is a fair coking coal. The output in 1889 was 49,400 tons.

FOLIO 3, PLACERVILLE, CALIFORNIA, 1894.

This folio consists of $1\frac{1}{2}$ pages of text descriptive of the Gold Belt and $1\frac{1}{2}$ pages descriptive of the Placerville district, signed by Waldemar Lindgren and H. W. Turner, geologists, and G. F. Becker, geologist in charge; a topographic map (scale 1:125,000) of the district, a sheet showing the areal geology, another showing the economic geology, and a third exhibiting structure sections.

Geography.—The territory represented lies between the meridians 120° 30′ and 121° and the parallels 38° 30′ and 39°, and contains 925 square miles. It is located in the upper foothill region of the Sierra Nevada, the elevation ranging from 300 feet to 5,400. The prevailing character of the topography is that of irregular and undulating plateaus, cut by deep canyons and steep ravines. The district is drained by the three forks of the American River in the northern part and by the three forks of the Cosumnes River in the southern part.

Geology.—The eastern half of the tract is principally composed of a somewhat metamorphosed sedimentary series, the Calaveras formation, of presumable Carboniferous age. The rocks consist chiefly of clay slates and quartzitic sandstones, and have in general a northerly strike and steep easterly dip. Several irregular intrusive masses of granitic rocks are contained in the sedimentary series. The western half of the tract is much more complicated. A belt of black slates belonging to the Mariposa formation, of late Jurassic age, traverses the tract from north to south. To the west of this belt follow again sedimentary rocks of the Calaveras formation, greatly cut up by igneous rocks. The sedimentary rocks here, as well as in the western part, have a northerly strike and steep easterly dip. The western part of the area contains a great abundance of basic igneous rocks, consisting of diabase, augite, hornblendic porphyrite, gabbro-diorite, pyroxenite and serpentine. Over large areas certain of these basic rocks have been converted to amphibolitic schists by dynamo-metamorphic processes. Covering the ridges and resting unconformably on the older rocks are large masses of Neocene effusive rocks, chiefly tuffs and breccias of rhyolite and andesite. These masses form gently sloping tables, underneath which the Neocene gravel channels are found.

Economic Geology.—The Neocene River channels, with very highly auriferous gravel, are exposed and mined at several places in the area, for instance, at Todd's Valley, near Georgetown, and in the vicinity of Placerville. Many and important auriferous quartz veins are found in the area. The principal ones occur along the belt of Mariposa slates previously mentioned, and form the northern end of what is usually referred to as the Mother Lode of California. Passing by Nashville and Placerville, the vein is almost continuous up to the northern part of the area, where it splits up into several branches, which die out before reaching the northern border. Important veins are, however, also found both to the east and west of this belt. Near the eastern line lies the important mining district of Grizzly Flat.

There are practically no alluvial soils in the area. The deep soil on the summit of the ridges is always a residual soil, formed by the decomposition of the rocks in place.

FOLIO 5, SACRAMENTO, CALIFORNIA, 1894.

This folio consists of 1½ pages of text descriptive of the Gold Belt and 1½ pages descriptive of the Sacramento tract, signed by Waldemar Lindgren, geologist, and G. F. Becker, geologist in charge; a topographic map (scale 1:125,000) of the tract, a sheet showing the areal geology, another showing the economic geology, and a third exhibiting structure sections.

Topography.—The Sacramento tract includes the territory between the meridians 121° and 121°30′ and the parallels 38°30′ and 39°, and contains 925 square miles. The western half of the tract embraces a part of the Sacramento Valley, while the eastern half contains the first foothills of the Sierra Nevada. The elevation ranges from 30 feet above sea level at Sacramento to 2,100 feet in the northeastern corner of the tract. The foothill region forms a sloping and undulating table land, through which the American River has cut a deep and narrow canyon.

Geology.—A small area of sedimentary slates of the Calaveras formation (Carboniferous) occurs in the northeastern corner, and a belt of black clay slates belonging to the Mariposa formation (late Jurassic) is contained in the igneous rocks of the southeastern part. At Folsom the Mariposa slates are cut off and contact metamorphosed by the granitic rocks of the Rocklin massif. The larger part of the older rocks of this tract is of igneous origin. A large area of diabase and porphyrite is found along the eastern margin. Wide belts of these rocks have been rendered schistose and changed to amphibolites by dynamo-matamorphic processes. Several masses of granodiorite and gabbrodiorite have been intruded into the diabases, porphyrites and amphibolites. Small masses of serpentine are sometimes found in the amphibolite; others appear intimately connected with gabbrodiorite.

Superficial flows of andesitic tuffs and breccias cover the older rocks. The larger part of these flows has been eroded. The remaining masses form sloping tables in the lower foothill region. Auriferous gravel channels are found in places below these volcanic rocks. At an elevation of 300 feet the andesite is underlain by clays and sands of the Ione formation, deposited in the gulf which in Neocene times skirted the foothills of the Sierra Nevada. The western part of the tract is largely covered by early Pleistocene deposits of gravel, sand and hardpan.

Economic Geology.—Neocene auriferous gravels have been worked to some extent east of Rocklin and south of Auburn. The Pleistocene gravels in the foothills have been very rich in gold, but are now mostly exhausted. At Folsom large masses of Pleistocene gravels are still worked. Auriferous quartz veins have been extensively

worked between Ophir and Auburn. Small veins are occasionally worked near Clarksville and in the vicinity of Pilot Hill.

The central mass of granodiorite affords excellent building stone. Limestones occur chiefly as lenses in amphibolite at many places along the eastern border. The soils of the foothill region are residuary in character, while the western part of the tract is occupied by deep alluvial and sedimentary soils.

FOLIO 7, PIKE'S PEAK, MONTANA, 1894.

This folio consists of $4\frac{1}{2}$ pages of text, signed by Whitman Cross, geologist, a topographic sheet (scale 1:125,000), a sheet of areal geology, one of economic geology, and one of structure sections, followed by a special description of the Cripple Creek mining district, consisting of 1 page of text on the mining geology by R. A. F. Penrose, Jr., and a map (scale 1:25,000) showing the economic geology of the district.

Geography.—The district embraces an area of 931.5 square miles between the meridians 105° and 105° 30′ and parallels 38° 30′ and 39°. In the eastern half of the district lies the crest of the granitic Colorado Range, which extends from Manitou Park through Pike's Peak to the southern end of the range, where it sinks to the level of the plains. The western portion of the area is a plateau, of granite and volcanic rocks, lying between 8,000 and 10,000 feet in elevation, penetrated on the south by deep canyons of streams tributary to the Arkansas River and by the recess or bay of Garden Park, nearly at the level of the plains. The principal drainage of the district is by tributaries of the Arkansas River, which flows through the Royal Gorge just beyond the southern boundary. The remaining drainage is into the Platte River, which cuts across the northwestern corner of the area in a deep canyon.

The Colorado Midland Railroad traverses the district from east to west near its northern boundary. East of the center of the area is the mining district of Cripple Creek, reached by branch railroads from the north and south.

General Geology.—The granites of the mountain and plateau regions are reddish in color, coarse or fine grained, and similar to those of many other regions in Colorado. Of special interest is the observation, first made by the survey corps, that these granites contain many large and small fragments of metamorphosed stratified rocks, quartzites and schists belonging to the oldest series of sedimentary beds, the Algonkian, and hence the granites are not of Archean age, as has previously been assumed. Most, if not all, of the gneisses in this district have been formed from the granites by a shearing strain, as is very clearly demonstrated in many places.

The sedimentary formations of the area and their characteristics of special interest may be concisely referred to as follows:

Algonkian. Nearly 4,000 feet of white quartzite, in small part conglomeritic, is shown in the huge inclusion in granite in Wilson Park. These ancient strata are not known in this region except as inclusions.

Silurian. Three divisions of the Silurian strata, each about 100 feet thick, have been recognized in Garden Park, and named respectively the Manitou limestone, Harding sandstone and Fremont limestone. The Harding sandstone contains the oldest fossil fishes as yet known. Minor unconformities separate these formations, and they are not known in so good development elsewhere.

Carboniferous. Resting on the Silurian is a thin limestone, called the Millsap, carrying a few Carboniferous shells, and known only in small remnants. The red sandstones and grits of Manitou and Garden Parks, 1,000 feet in thickness, are considered as of Carboniferous age and named

the Fountain formation. No fossils are known in them.

The strata of the Juratrias and Cretaceous have been found in remnants upon the granite plateau, indicating a former extension of these beds connecting with South Park.

Eocene. The small lake deposit about Florissant is noted the world over for its fossil insects, while fishes, birds and many plants are also found in these thin beds, which are chiefly made up of volcanic ashes.

The volcanic rocks of the district are numerous and interesting. Those of the western portion belong to a great volcanic center south of South Park. At Cripple Creek is a local volcanic vent, the peculiar product of which is the rare rock phonolite.

Many points in the geological history of the Colorado Range have been brought out by the recent survey, such as the evidence of varying relations between land and sea at different periods, shown by unconformities and by remnants of strata on the granite plateau. The shear zones shown by the gneisses, and the observed folds and faults of the foothills, bear directly upon the structural history of this portion of the Rocky Mountains.

Economic Geology.—The gold-bearing district of Cripple Creek is directly connected with the volcanic center. The gold ores are free milling near the surface, but pass into telluride smelting ores in depth. They occur in veins, chiefly in the volcanic rocks, but occasionally in the granite near them. The extreme alteration of the rocks of the eruptive center, and the unusual character of the gold veins, have made a detailed study of the mining district necessary. A special topographic and geologic map on the scale $\frac{1}{25000}$, or nearly $2\frac{1}{2}$ inches to the mile, has been made, and the ore deposits have been thoroughly examined by Prof. R. A. F. Penrose, Jr.

FOLIO 9, ANTHRACITE–CRESTED BUTTE, COLORADO, 1894.

This double folio consists of 3 pages of text descriptive of the Elk Mountains, by S. F. Emmons; 2 pages descriptive of the igneous formations of the two districts, by Whitman Cross; 4 pages descriptive of the sedimentary formations, by G. H. Eldridge; of each of the two districts a topographic map (scale 1:62,500), a map of areal geology, another of economic geology, and a third of structure sections; and finally, a sheet showing a generalized columnar section for the two districts.

Geography.—The combined area represented on the two sheets covers one-eighth of a degree, lying between the parallels 38° 45′ and 39° and the meridians 106° 45′ and 107° 15′, and is about $27\frac{1}{2}$ miles long from east to west and $17\frac{1}{2}$ from north to south. It includes the southern third of the Elk Mountain group, which lies between the Sawatch Range on the east and the plateau of the Colorado basin on the west. It is a highly picturesque and mountainous region, and, like the San Juan Mountains to the south, has a more abundant precipitation and is more alpine in its character than other parts of the Rocky Mountains.

The northern half of the eastern or Crested Butte tract is occupied by the southern portion of the Elk Mountains proper, whose culminating points have an elevation of over 13,000 feet; the southeastern portion of that tract includes the distinct and less elevated Cement Mountain uplift. The rest of this area and the whole of the Anthracite tract is occupied by more or less isolated mountain peaks—Crested Butte, Gothic Mountain, Mount Wheatstone, etc., and by one prominent north-and-south ridge, the Ruby Range, whose higher summits rise between 12,000 and 13,000 feet above sea level.

The drainage of all this area finds its

way through the Gunnison River into the Colorado, and the greater part is carried to the latter stream through the southward-flowing Slate River and its tributaries.

The towns of Crested Butte (9,000 feet) and Baldwin (8,750 feet), which are near active coal mines, are reached by branches of the Denver and Rio Grande and the Denver and South Park railroads respectively. Other towns higher in the mountains, which were founded by silver miners, are Gothic, Pittsburg and Irwin. Owing to its great altitude and abundant precipitation, this region is more or less snow-bound during eight months of the year, and mining is thereby rendered difficult and costly.

Geologic Structure.—The most striking feature in the geology of the region is the great development of eruptive rocks which occur: as irregular bodies cutting across disturbed and upturned strata; as laccolitic bodies doming up the nearly horizontal strata above a given horizon; as vertical and comparatively narrow dikes; to a limited extent as surface flows; and as a bedded series of breccias, tuffs and conglomerates.

Eruptive activity was most energetic and widespread during the Eocene Tertiary; it continued, however, sporadically, during later periods, the most recent outpourings of lava being probably of Pleistocene age. The principal rock types represented are: in the irregular cross-cutting masses, granite and diorite, and at a later period and in limited areas, rhyolite; the laccolites are mostly of porphyrite; among dike rocks are found diorite, porphyritic diorite, porphyrite and quartz porphyry; basalt occurs as a surface flow, and andesitic debris in the tuffs and conglomerates of the bedded series.

Among sedimentary rocks in this region are found representatives of the principal formations from the Archean up to the close of the Mesozoic, with some later formations whose exact age is still somewhat doubtful. The Cambrian is represented by the Sawatch quartzite, which consists of 50 to 200 feet of white quartzite, congloméritic at the base, and at certain horizons persistently glauconitic; its fossils are of the Potsdam type.

The Silurian beds, which are locally called the Yule limestone, in an aggregate thickness of 350 to 450 feet, consist mainly of limestones, with quartzite at the base and more shaly beds at the top. They contain the same fish remains that characterize the Harding sandstone of the Canyon City section, but organic remains have not been discovered in sufficient abundance to admit of the subdivision of the series on a paleontologic basis.

The Carboniferous is represented by three subdivisions. (1) The Leadville limestone, or Lower Carboniferous, has a thickness of 400–525 feet of dark gray or blue limestones, with some intercalated quartzites and shales. Above this is (2) the Weber formation, which consists of 100–500 feet of shales and limestones, carrying fossils of Coal Measure type. The upper member, known as (3) the Maroon conglomerate, consists mainly, as its name indicates, of conglomerates, which are characterized by the local abundance of pebbles of limestone. It has an observed maximum thickness of 4,500 feet, and in its upper portion resembles lithologically the Red Beds, generally assigned to the Trias.

The Juratrias, whose beds are separated from the last mentioned by a great unconformity, is represented by the Gunnison formation, which consists of a heavy white sandstone, about 100 feet in thickness, overlain by shales and a little limestone, and carries a fresh water-fauna of supposed Jurassic age.

The Cretaceous is represented by five recognized subdivisions: The Dakota

quartzite, 50–300 feet thick; the Benton shale, 150–300 feet thick; the Niobrara limestone, 100–200 feet thick; the Montana formation, comprising the Pierre shales and Fox Hills sandstones, 600–2,000 feet thick; the prevailing lithologic characteristics of each of which are indicated by its name. Among later beds are the Ohio formation, about 200 feet of sandstones and conglomerates, and the Ruby formation, with a maximum thickness of 2,500 feet of sandstones, shales and conglomerates made up to a large extent of eruptive debris. These formations are separated by an unconformity from the underlying Laramie, and to the west of this area pass beneath the beds of the Wasatch Eocene; in the absence of fossil evidence they have been classed as Cretaceous.

The geologic structure of this region affords evidence of no less than four important orographic movements, involving the making of new land, the erosion and planing down of the same and the inauguration of a new cycle of sedimentation, which account for the great variation in thickness of certain formations. First, during Post-Archean time, the first deposits, after which were Upper Cambrian (Sawatch quartzite); second, during Carboniferous time, followed by deposition of Weber shales and Maroon conglomerates; third, during Mesozoic time, followed by deposition of the Gunnison sandstone; and fourth, after Laramie time, followed by the Ohio, Ruby and Eocene formations.

Mineral Resources.—The most important economic product of the region is its coal, which is found in the lower part of the Laramie Cretaceous formation, between beds of sandstone. The quality of the coal varies, according to local conditions more or less favorable to metamorphism, from dry bituminous, through coking coal, to semi-anthracite and anthracite. Next in importance are its silver ores, which occur for the most part in true veins or fault fissures in all varieties of rock, but mainly in the sedimentary beds of upper horizons near eruptive rocks. The ores are generally rich, but in small bodies, and, in consequence of natural obstacles to cheap mining, have not been extensively worked. Gold has been found in paying quantities in the alluvium of a single gulch; lead and copper are accessory products in limited amounts.

FOLIO 10, HARPER'S FERRY, VIRGINIA, MARYLAND, WEST VIRGINIA, 1894.

This folio consists of 4 pages of descriptive text, signed by Arthur Keith, geologist; 1 page of columnar section, a topographic map (scale 1:125,000), a sheet showing the areal geology of the district, another showing the economic geology, and a third exhibiting structure sections.

The folio describes that portion of the Appalachian province which is situated between parallels 39° and 39° 30′ and meridians 77° 30′ and 78°. The tract contains about 950 square miles and falls within Washington and Frederick counties, Maryland; Loudoun and Fauquier counties, Virginia; and Jefferson county, West Virginia.

The folio begins with a general description of the province, which shows the relation of the Harper's Ferry tract to the whole. Then the local features of the drainage by the Potomac and Shenandoah rivers and their tributaries (Goose, Antietam and Catoctin creeks) are treated. The various forms of the surface are pointed out, such as Shenandoah Valley, Blue Ridge and Catoctin Mountain, and their relations to the underlying rocks are made clear.

Under the heading Stratigraphy the geologic history of the Appalachian province is presented in outline, and the local rock groups are fully described in regard to composition, thickness, location, varieties, and mode of deposition.

The formations range in age from Algonkian to Cretaceous, the greater portion being Algonkian, Cambrian and Silurian. The Silurian rocks appear in the Shenandoah Valley, the Cambrian in Catoctin Mountain and Blue Ridge, the Algonkian between these ridges, and the Jaratrias east of Catoctin. The Algonkian rocks are chiefly granite and epidotic schist ; the Cambrian rocks, sandstones and shales, passing up into limestones ; the Silurian rocks, limestones and shales ; and the Juratrias rocks, red sandstone and shale and limestone conglomerate. The details of the strata are shown in the columnar section. The manner in which each kind of rock decays is discussed, and how the residual soils and forms of surface depend on the nature of the underlying rock.

In the discussion of Structure, after a general statement of the broader structural features of the province, three methods are shown in which the rocks have been deformed. Of these the extreme Appalachian folding is the chief; next is that developed in the Juratrias rocks, and least in importance are the broad vertical uplifts. Three degrees of extreme deformation appear in the Paleozoic rocks—folding, faulting and metamorphism—each being best developed in a certain kind of strata. Between Blue Ridge and Catoctin Mountain the Algonkian or oldest rocks appear on a great anticlinal uplift, with Cambrian rocks on either side. Faults appear chiefly on the west side of this uplift, and metamorphism increases toward its east side. In the Shenandoah Valley the rocks are folded to an extreme degree, and the strata are frequently horizontal or overturned. The Juratrias rocks always dip toward the west, and are probably repeated by faults different in nature from the Appalachian faults. In the sheet of sections the details of the folds and faults appear.

Economic products of this region comprise copper and iron ore; ornamental stones, such as marble, limestone conglomerate and amygdaloid; building stones, such as sandstone, limestone and slate; and other materials like lime, cement, brick clay and road materials. The localities of each of these materials are noted and quarries located on the economic sheet, and the character and availability of the deposits are discussed.

AMERICAN FOSSIL BRACHIOPODA.

THE writer has had in preparation since 1886 'A Synopsis of American Fossil Brachiopoda, including Bibliography and Synonymy.' This work, now completed, will appear as one of the Bulletins of the U. S. National Museum and embraces the following chapters: I. Geological Development; II. Brachiopod Terminology; III. Biological Development; IV. Morphology of the Brachia, by Charles E. Beecher; V. Classification; and VI. Index and Bibliography. The following summary, taken from this work, gives some of the more important results obtained, all of which are discussed at length in the work above cited.

In North America there are one thousand eight hundred and forty-six Paleozoic, thirty-seven Mesozoic, and nine Cenozoic species of fossil Brachiopoda. There are one hundred and one species in the Cambrian, three hundred and eleven in the Ordovician, three hundred and twenty in the Silurian, six hundred and fifty-five in the Devonian, and four hundred and eighty-two in the Carboniferous.

This remarkable scarcity of Post-Paleozoic species in America is supposed to be due not so much to the general decline of of the class as to great orographic movements during the close of the Paleozoic, thus producing complete barriers against the introduction of species from other areas. Moreover, few marine sediments are found in them.